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6 Results of Current Measurements  
with Drogues, 1963-1964

Sponsored by :

The Marine Research Committee of  
the State of California  
The Office of Naval Research  
National Science Foundation

10 Daniel M. Brown

14 SIO Reference 65-3

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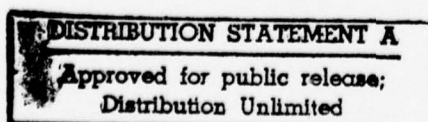
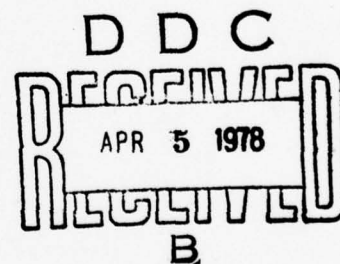
RESULTS OF CURRENT MEASUREMENTS WITH DROGUES,  
1963-1964

Daniel M. Brown

Sponsored by  
The Marine Research Committee of the  
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National Science Foundation

SIO Ref 65-3 ✓



Approved for distribution:

*T. N. Spiess*

T. N. SPIESS, Director

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## INTRODUCTION

↙ This report gives the results of a number of drogue surveys conducted by the University of California's Scripps Institution of Oceanography. These current measuring surveys were carried out in support of biological work being conducted at the same time. This report covers those cruises not previously published, that occurred during 1963 and 1964.

These surveys were sponsored in part by the Marine Research Committee of the State of California in the California Cooperative Oceanic Fisheries Investigations; in part by the Office of Naval Research; and in part by the National Science Foundation.

→ Throughout all these surveys a standardized drogue was used, consisting of a 20-foot bamboo pole, radar reflector, flags, and an inner tube float. Surplus parachutes were used as the drogue device which would sea-anchor the drogue to the current under study. Details of construction, survey techniques, and tables to correct for the effects of windage on the poles, and water drag on the floats are too lengthy to discuss here, but are available in a manual for technicians.

→ Since there is no uniform pattern to any of the drogue surveys, each cruise and its data has to be presented individually. Charts of movement and tables of positions or times are presented so that the reader may extract whatever degree of detail he wishes. For earlier cruises, see SIO Reference 62-27, Results of Current Measurements with drogues 1958-1961.

DANIEL M. BROWN

SAN ONOFRE SURVEY

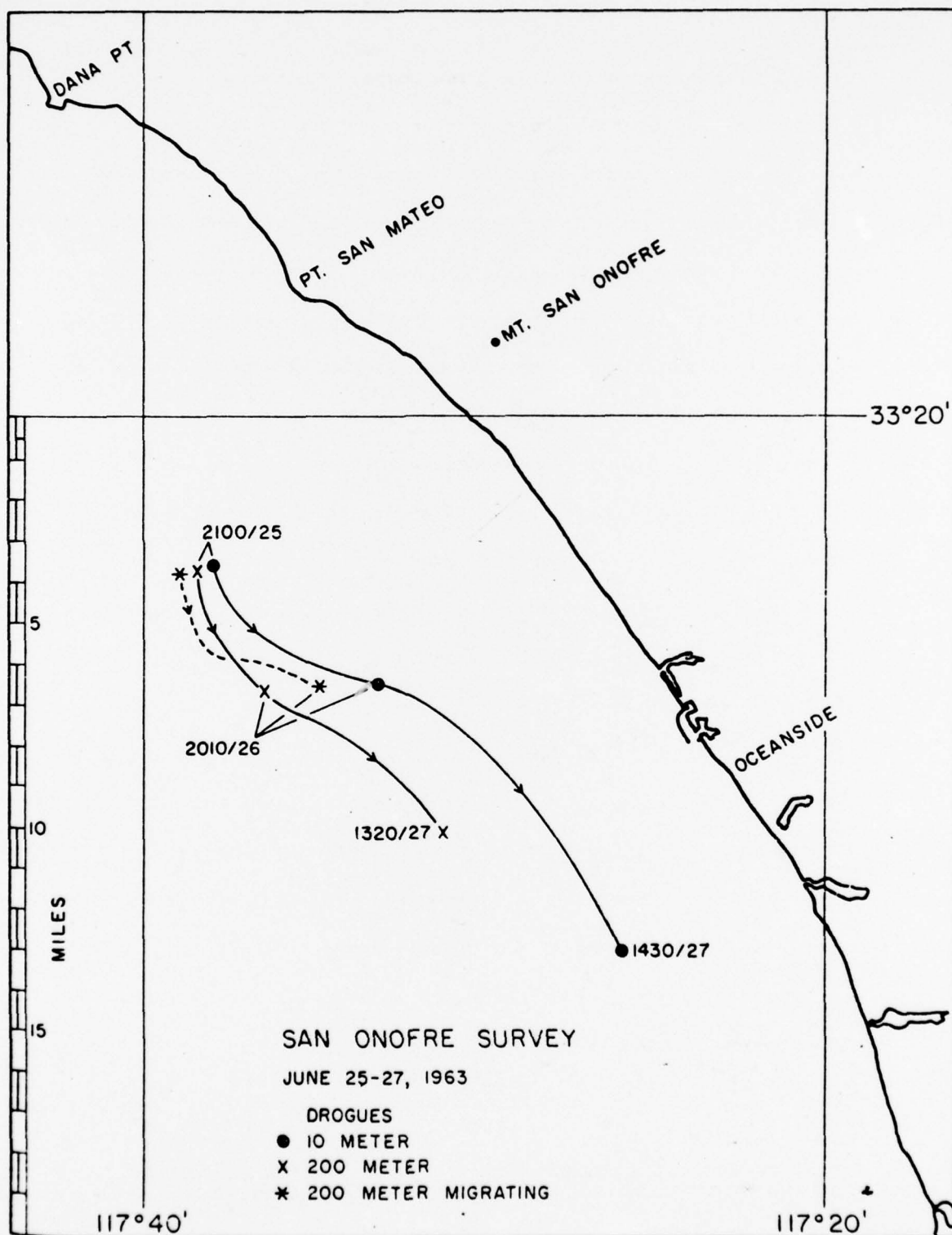
June, 1963

Two drogues, and an experimental migrating drogue, were launched near an anchored instrument buoy in conjunction with an internal wave study being carried out in the area.

Wind was light and variable through the evening hours, and moderate westerly in the afternoon. Sea was calm for the most part with only a light afternoon chop.

A 200-meter, and 10-meter drogue were tracked for 23 hours, and later found again the following day by another ship. The tracks on the chart have been corrected for windage and water drag.

The experimental migrating drogue was started out at the same 200-meter depth as the standard deep drogue, and allowed to travel several hours at that depth. The parachute was started up on the migrating drogue, but its path still paralleled that of the deep drogue for 2 hours, or until the parachute was almost to 10 meters. It then abruptly changed direction towards the other 10-meter drogue. From the behavior of this drogue which samples currents at all the depths in between, so to speak, it was evident that the stronger surface current was restricted to a relatively shallow layer near the surface.



AZUL II

September 9 - 10, 1963

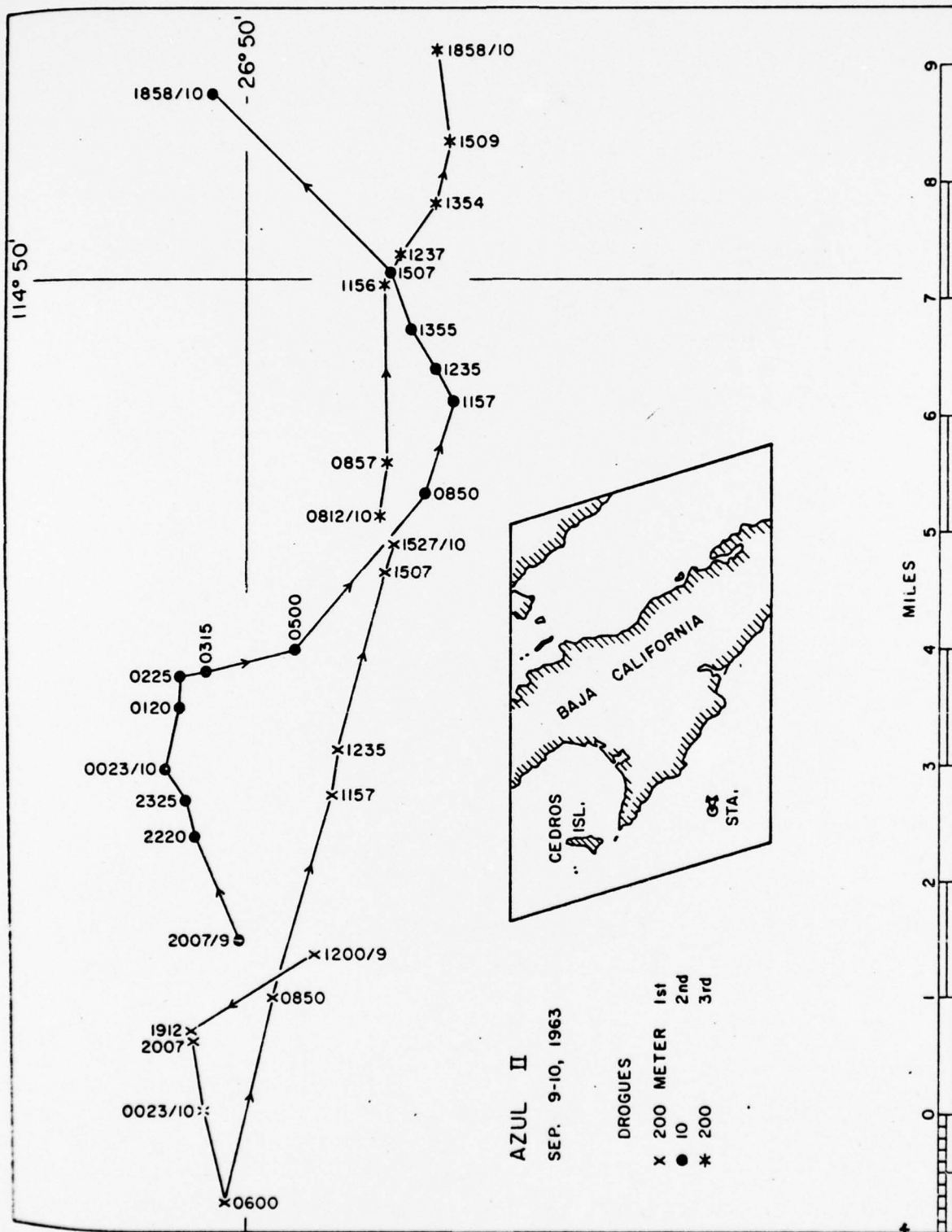
The drogues on this station were set for the purpose of staking out a patch of water for an extended period of biological sampling.

During the daylight hours on the 9th, a 200-meter drogue was followed and used as the local reference point around which a net tow series was made. An experimental migrating drogue was used also but it malfunctioned. In the evening when the deep scattering layer had come to the surface, a 10-meter drogue was launched (at 2007) around which we worked during the night so as to follow our same biological mass that had been deeper during the day. We followed the 10-meter drogue until dawn. At 0812 after the scattering layer had gone down we put down another 200-meter drogue and used it as our reference point.

On the chart the geographical drift of all the drogues is shown and the order in which they were launched is indicated in the notations.

Position of the 1st 200-meter drogue was determined by celestial fixes and the positions of the other drogues were related to it, by radar plot. The absolute positioning may be in error because of the inherent errors of celestial plotting, but the relative fixes of the drogues to each other are quite good.

From the drogues, it can be seen that the surface current was moving along faster than the deeper water, and during part of the night was even going in the opposite direction when the deeper water reversed its course.





EL GOLFO

DROGUE SURVEY

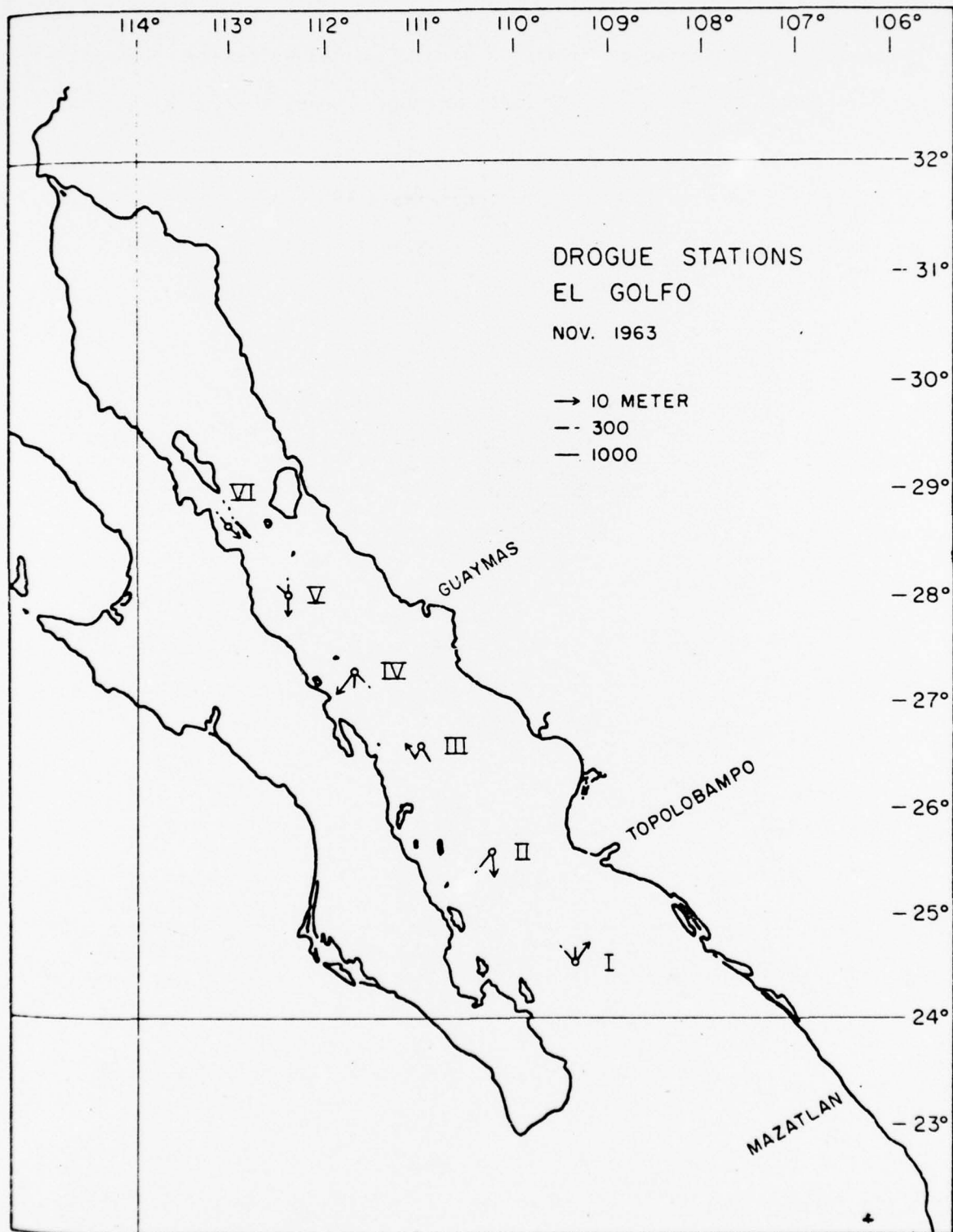
A series of 6 drogue stations were run in the Gulf of California during November, 1963 in conjunction with a biological survey. The purpose was to gain some insight into the distribution of plankton in the Gulf and by use of opening and closing nets at selected levels, try to see how plankton distribution tied in with current circulation.

To do this a deep reference drogue was launched which would act as the anchor point of our survey work while on station. This drogue was deep down and was expected to move only very slowly and would allow us to stay within a given area more easily than by trying to fix ourselves to some distant land mark. Smaller drogues were launched at selected depths and their movements charted to give the speed and direction of the currents.

A summary of drogue movements and station locations are shown on the general area chart.

The anchor or main reference drogue was a large 30-foot long bamboo pole with flags, lights, and a spherical radar reflector on it. Floatation was provided by a 2-foot cube of foam plastic. 1000 meters of .086 piano wire connected the float to the parachute drogue at depth. Since the windage and water drag corrections for the anchor drogue were so large only under relatively calm seas, and slow surface currents could the anchor drogue be useful in yielding accurate current measurements, still its actions would be useful in getting some idea of deep water movement. Its main function was as a large local reference point around which we would work while doing closing-net tow series while on station. Since it could be seen on radar for some 8 miles we could use it to keep





a plot of the smaller drogues relative to it, and then position the anchor drogue relative to the land to obtain the geographical drift of the entire drogue group. All the other drogues were our standard ones, a 20-foot bamboo pole, 2-foot lifeboat radar reflector, flag, number board, and innertube floatation. The drogues were sent to depth on .086 piano wire where the 28-foot parachutes would be held down by the ballast on the end of the wire. Since our time on station would be short we used a quick ballast release system to send the chutes down closed, thus getting them to their operating depths rapidly and allowing for longer current measurement time while on station. The anchor drogue was always recovered at the end of each station and was used on all 6 stations in the Gulf.

On the charts of the stations in this Gulf survey the drogues are plotted for their corrected positions. That is, the effects of windage and water drag on the surface units have already been accounted for, so that the net drift due to tide and current drift can be determined. The times of observations are either listed separately or are noted alongside the positions where space allows. When times of observations are listed separately the drogue positions are each plotted according to the successive times listed. This is necessary where drogue paths are crowded together. All positions, and times are shown so that any observer may extract whatever degree of information he wishes, to suit his particular interests.

Times of all positions are in Pacific Standard Time.

STATION I

EL GOLFO

November 13 - 15, 1963

The drogues on Station I were launched around 1000 PST, November 13, 1963 but the first fixes were not recorded until 1155 PST when all the chutes had been open and the drogues settled down. Wind and sea was for the most part calm, with only light winds springing from here and there so that the drogues were not subject to any large windage corrections. A prominent peak on Isla Cerralbo 33 miles away gave a good radar reference point and was used throughout the survey of this station for obtaining the geographical positions of the anchor drogue. The standard drogues were sent to 300, 200, 100, 50 and 10 meters.

On the station chart the successive times are listed and the drogues are all plotted accordingly. In addition the starting and finishing times are noted by their positions.

Tidal data for the Gulf was obtained from the Tide Tables published by the Oceanographic Office, and the times converted to Pacific Standard Time so as to correspond to the times used on the charts. Tidal data for Station I show the following:

<u>Nov. 13</u>	0145	1.1 ft.	<u>Nov. 14</u>	0200	1.2 ft.	<u>Nov. 15</u>	0217	1.5 ft.
	0811	2.4 ft.		0813	2.4 ft.		0809	2.4 ft.
	1501	0.0 ft.		1514	-0.2 ft.			
	2143	1.9 ft.		2224	1.9 ft.			

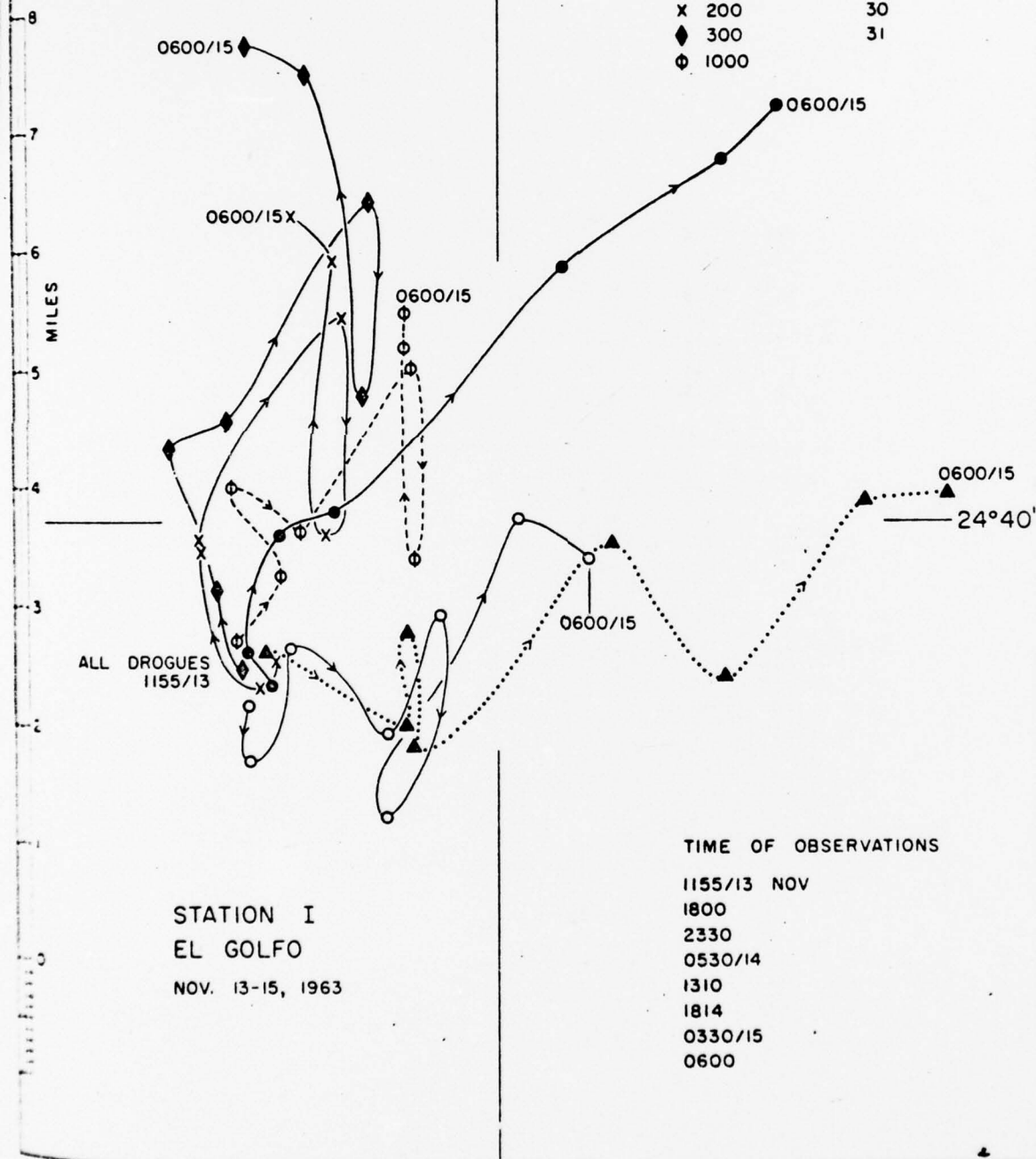
The overall drift of water on this station was to the NE down to 100 meters, and to the north from 200 to 300 meters. From an odd trace characteristic in the electric BT traces it would appear that the 150-meter depth marked the area of the switch between the upper and lower water movements. Even the 1000-meter anchor drogue shows a pretty fair drift to the NE. All the drogues seem to be affected by tidal movement, which probably is the cause for the north and south movements of all the drogues along their paths of drift.

10

109° 20'

## DROGUES

●	10 METER NO. 29
○	50
▲	100
x	200
◆	300
⊕	1000
	27
	28
	30
	31



STATION II

EL GOLFO

November 17 - 18, 1963

Drogues were launched in the early hours of the 17th and the initial positions plotted at 0400, November 17th. The big anchor drogue was sent to a depth of 1000 meters. Standard drogues were sent to 300, 100, 50 and 10 meters.

Geographical fixes from a prominent radar spot on Isla Catalina, 30 miles away were made to keep track of the drift of the anchor drogue. The other drogues were positioned from the anchor drogue by radar plot. Wind was from the NW at 15 knots most of the time but fell calm towards noon and shifted into the east with light airs by late afternoon. The sea state was slight with only about a 2-foot chop rolling with the NW wind. Good radar visibility made it possible to keep a good watch on the drogues during our entire time on station.

On the station chart the windage and water drag corrections have been applied to the drogue positions, and the times of observations have been applied to the drogue positions, and the times of observations are noted alongside the positions.

From the drogue behavior on this station it is evident that the entire water column from 300 meters to the surface is moving to the SW with minor changes in direction probably due to tidal influence. Tide tables show the following data, with times corrected to Pacific Standard Time.

<u>Nov. 17, 1963</u>	0155	+1.7,	0656	+2.5,	1523	-0.7
----------------------	------	-------	------	-------	------	------

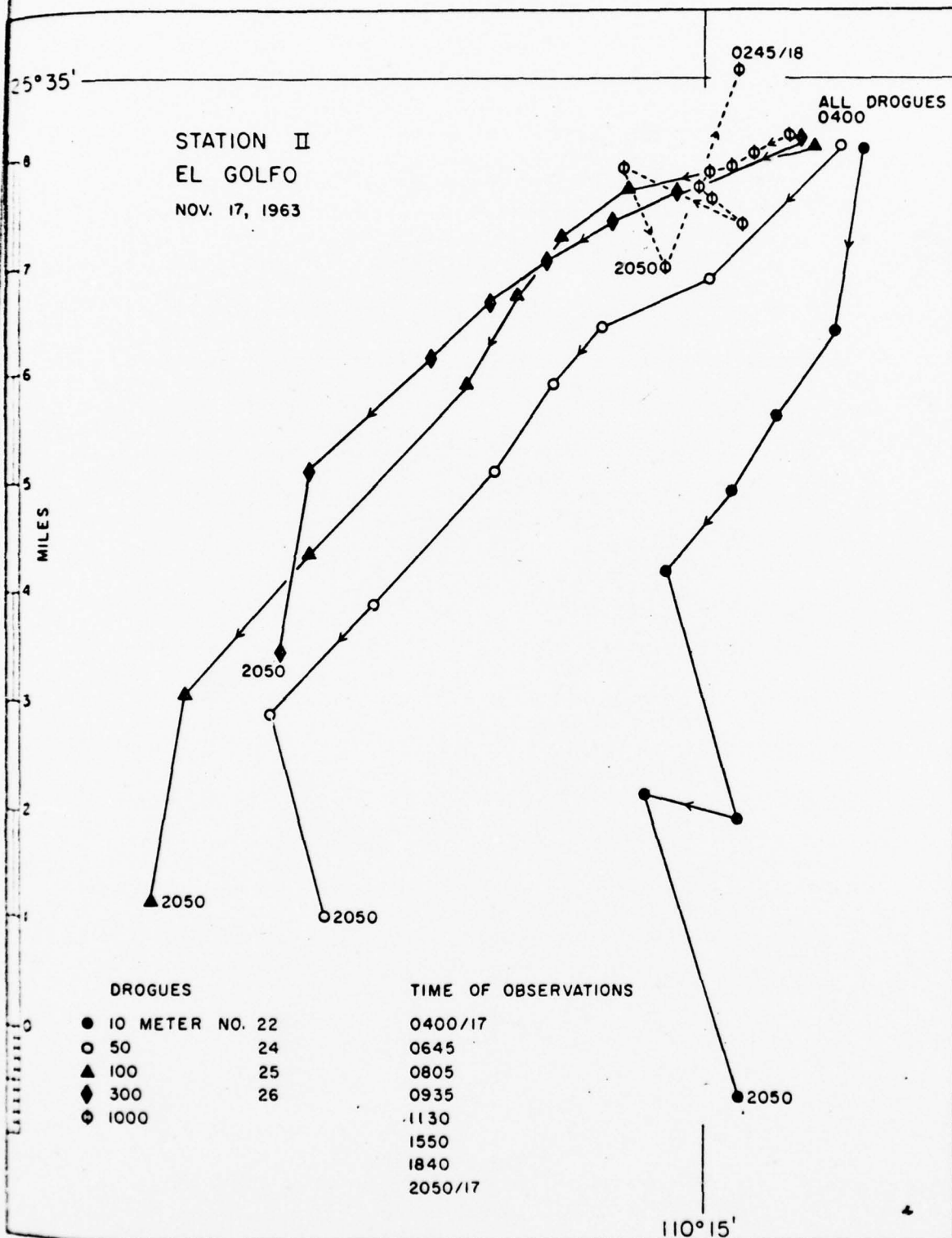
<u>Nov. 18, 1963</u>	0009	+1.9,	0204	+1.8,	0703	+2.7
----------------------	------	-------	------	-------	------	------



The behavior of the 1000-meter anchor drogue would indicate that the deep water on this station was probably only sloshing around under tidal influence and not really going much of anywhere.

After 2050 on the 17th the shallower standard drogues kept going southward while the anchor buoy turned around and went NE.

We soon lost radar contact with the shallower drogues and the 2050 position was their last fix. The last fix on the anchor drogue was at 0245 in the morning of November 18, before we retrieved the buoy.



STATION III

EL GOLFO

November 18 - 20, 1963

Station III was occupied about 25 miles from the Baja coast from November 18 to November 20, 1963.

Drogues were launched on the evening of the 18th and the launching positions were recorded at 2130 November 18. The anchor drogue was sent to a depth of 1000 meters (in 1590 meters of water) and the other standard drogues were sent to depths of 300, 200, 100, 50 and 10 meters.

Good radar and visual fixes off some prominent rocks on the coast and a nearby island provided excellent navigational positioning. The geographical drift of the anchor drogue was kept plotted, and the positions of the standard drogues relative to it were plotted from radar fixes. Sea state was slight and the wind held for the most part from the NW at around 10 knots, but began backing around to the south around midnight of the 20th and was blowing 12 knots from the south by noon of the 20th.

The first drogue to be lost from the pattern was the 50-meter drogue, #14, and its terminal position and time is shown on the map. The next drogue to be lost was #23, the 300-meter drogue, which we believe sank shortly after its terminal fix. The 10, 100, and 200-meter drogues were kept track of on radar up to the last fix at noon on the 20th when the station was terminated.

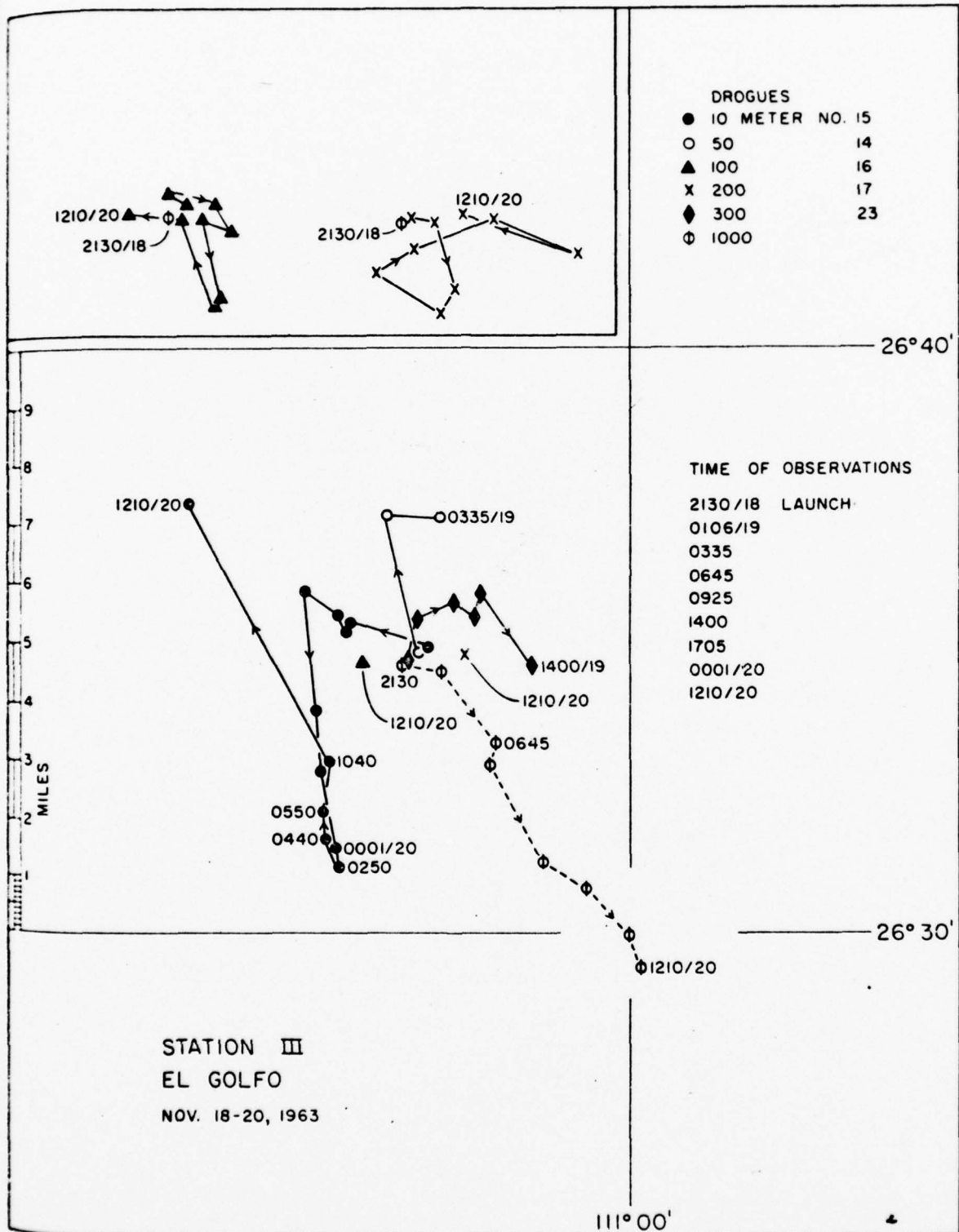
On the chart of this station, the launching and terminal fixes of all drogues are shown on the main chart. These tracks have all been corrected for windage and water drag errors.

The successive times of observations are listed on the chart from launch to terminal fix and the drogues are plotted accordingly. Since #14 and #23 were lost earlier, their terminal fix times are noted on the chart. In addition the times from 0001 PST November 20th until 1210 for the 10-meter drogue are shown on the chart since these extra positions did not correspond to the other times of observations for the other drogues. The dotted path of the 200-meter drogue shows the erratic path of this drogue relative to the others. Since both the 100-meter and 200-meter drogues crossed back and forth over the same area, their separate tracks, plotted on the same scale, and time sequence, are shown individually in the upper left hand corner. The position of the anchor drogue in this separate diagram corresponds to the 2130 PST launching fix on the main chart.

From the drogue behavior on this station it would appear that the water above the thermocline (30 to 42 meters from electric BT) moved around under the influence of possibly tide or wind stress influence, but in any event it behaved quite differently from the water below. From 50 meters to 300 meters, the erratic path and overall sluggish net movement would indicate an area of relative stagnation. At 1000 meters however, a very definite SE flow is indicated regardless of tidal stage.

Tidal data for these dates corrected to Pacific Standard Time show the following.

<u>November 19</u>	1716	+2.6 ft.,	1630	-0.6 ft.
<u>November 20</u>	0731	+2.7 ft.,	1713	-0.5 ft.



STATION IV

EL GOLFO

November 21 - 22, 1963

Station IV was perhaps the most unusual station of our entire group of drogue stations in that it was the only station that showed consistent water movement at all depths in the same general direction, and also contributed the highest current velocities observed, namely 1-3/4 knots for the 10-meter drogue.

Station IV was occupied in the early hours of November 21. The anchor drogue was sent to a depth of 1000 meters, and drogues at 300, 200, 100, 50 and 10 meters were launched on a line NW of the big anchor drogue. The initial positions were plotted at 0300 November 21. Good radar fixes were obtained from Isla Tortuga, and Point Chivata on the Baja coast. The geographical drift of the anchor buoy was plotted, and the positions of the standard drogues were plotted at the same time from the radar fixes. Radar conditions were unusually good in spite of the choppy sea, so that all the drogues could be followed until the afternoon of the 21st. The winds on this station were unusual in nature in that they were from the west. As such they came rolling down off the Baja mountains in great blasts. With the coming of daylight the wind began to ease off and for several hours around noon it was calm, and so was the sea. Toward evening the blasts began building up again so that by sunset we were having blasts of 30 knots or more, yet by only moving a mile or so we would run out of the wind lines. These blasts of wind would bring in a nasty short chop,



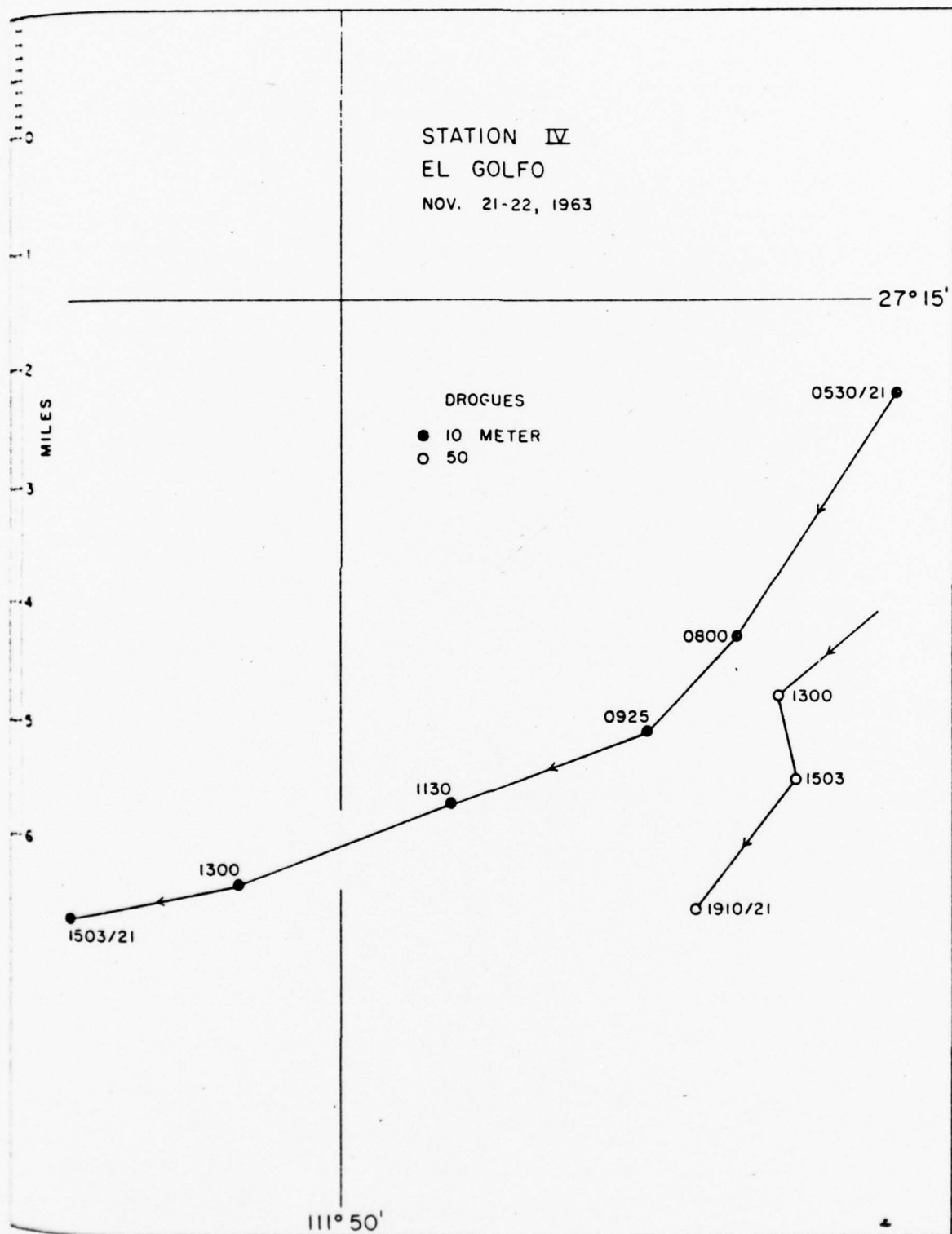
the border of which could be easily observed as a mass of breaking seas on one side and calm sea on the other. You could draw a line through the border. I mention the nature of these falling winds, and their nightly occurrence, since they appear to be a regular feature along the Baja coast from Agua Verde Bay to north of Santa Rosalia, not only during the winter months, but during the summer months as well, and undoubtedly play quite a role in the shaping of water currents along the Baja side of the Gulf.

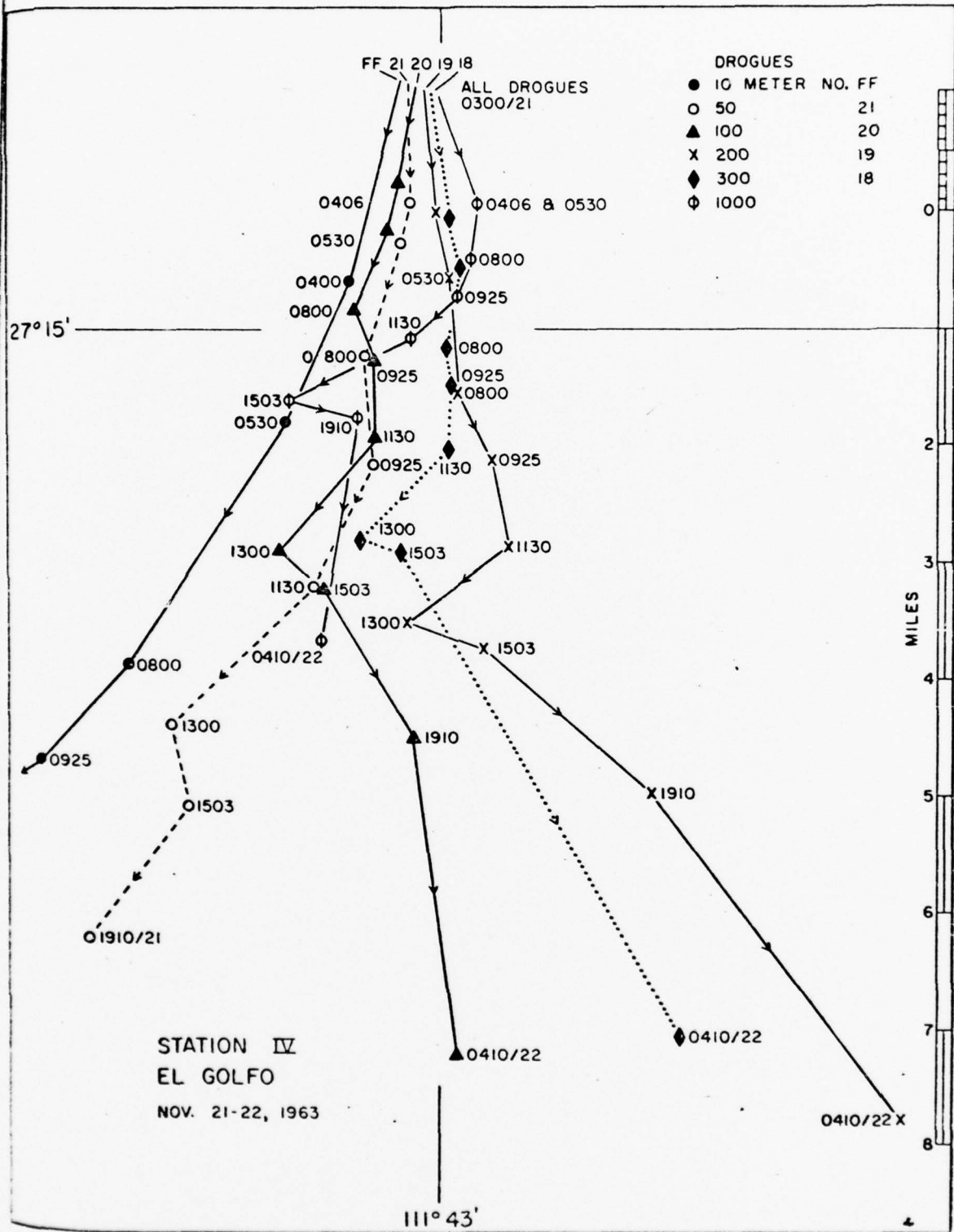
On the two maps of Station IV all positions of the drogues have been corrected for windage and water drag, including the large anchor drogue. The strength of the surface current was so strong however that no serious consideration should be given to current values derived by the 1000-meter anchor drogue since the corrections frequently exceeded the values of the observations. However, since it showed a steady drift southward the observations are useful in at least getting a general idea of the drift of the deep water. It is interesting to note that the entire water mass was moving southward with the 10-meter level going towards the west and the 200 to 300-meter levels going to the SE, a sort of Eckman spiral in reverse. The character of the electric BT traces on this station was entirely different than any of the other stations in that there was no deep even mixed layer, but rather a steadily sloping temperature gradient right from the surface.

Tidal data for this station corrected to Pacific Standard Time showed the following.

<u>November 21</u>	0741	2.6 ft.	1806	09.4 ft.
<u>November 22</u>	0712	2.4 ft.	1915	-0.2 ft.

The drogues did not appear to be influenced too much by the tide on this station since the tides were quite small.





STATION V

EL GOLFO

November 22 - 23, 1963

Station V was occupied twice due to heavy weather, hence two groups of drogues are presented.

The station was first occupied on the afternoon of November 22. At that time the fresh NW winds we had been encountering died somewhat, so all drogues were launched during what later turned out to be a momentary lull in the wind. The reference or anchor drogue was put to a depth of 600 meters, bottom was at 950 meters. Standard drogues at 300, 200, 100, 50, and 10 meters were also launched and initially positioned at 1700 PST. For geographical positioning a prominent bright spot on the radar scope on Isla San Pedro Martir some 22 miles away was used as the main reference point. Because the sea return was so bad on the radar scope we could not get fixes of the drogues relative to each other, so had to pull up alongside each drogue and position it from the island. It should be noted that on this station all drogue positions were plotted this way. The exact geographical position may be in error, but since the same bright radar reference point was used for all positioning the relative geographical plot is quite good.

Soon after launching the drogues it turned dark, and the wind rose to 30 knots out of the NW, and raised such a choppy sea that none of the standard drogues except the 10 meter one could be seen on the radar. The reference drogue was lighted and we kept track of it visually, and kept track of the 10-meter drogue until 2032 when it vanished from the scene going south at  $3/4$  knots. None of the other drogues were seen again until dawn when three of our drogues were located by visual search and

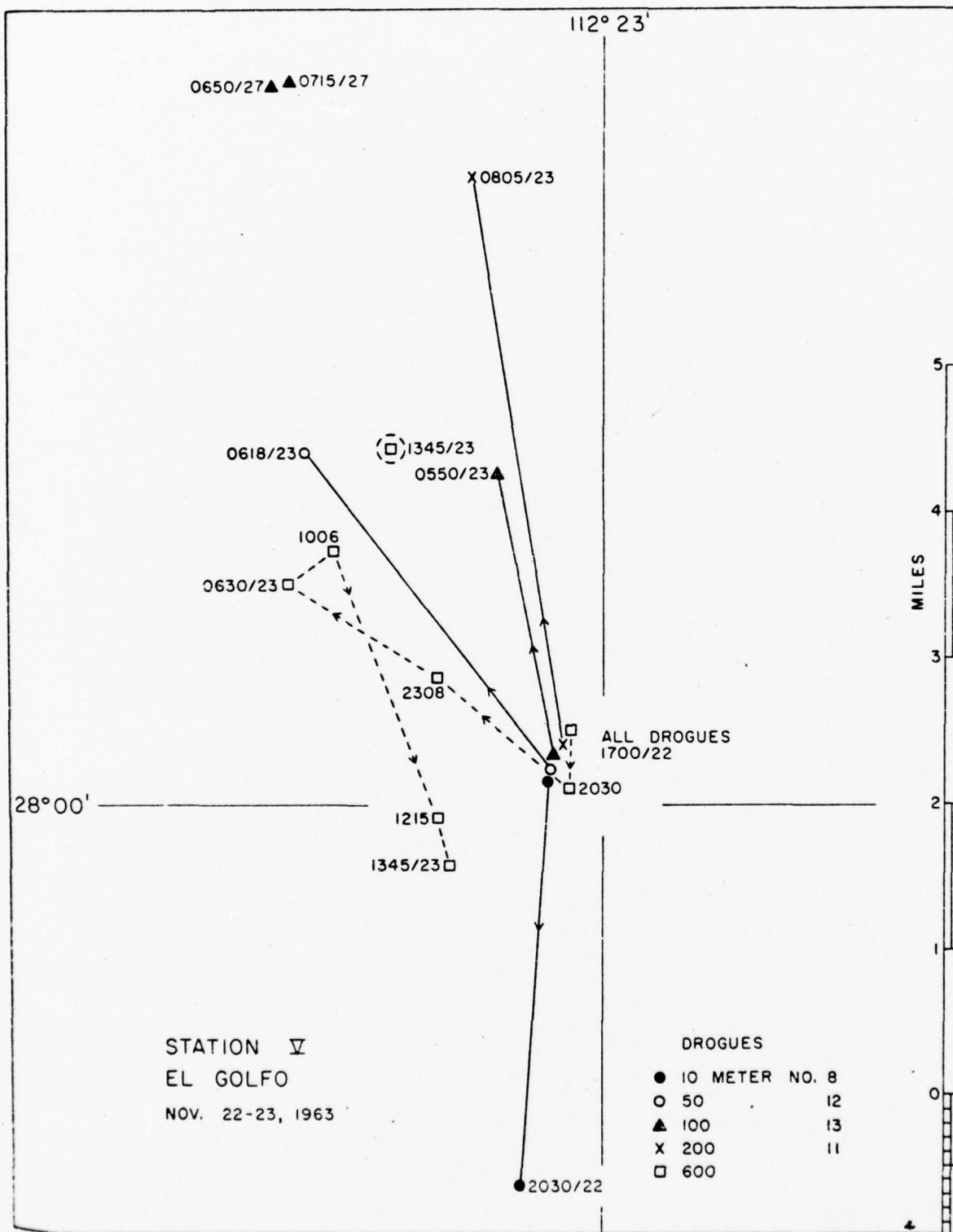
positioned from the island. As indicated by the map they were only seen once. #13, the 100-meter drogue, was found four days later in the position shown on the map when the station was reoccupied. After drifting WNW all night against 25 to 30-knot winds, the anchor drogue suddenly changed course and started rapidly south. Because its speed was around one knot we thought it had broken loose from its parachute, but it suddenly slowed down around noon, and when we retrieved it we found the parachute was still on the line. (Although the chute was down 600 meters, as soon as the wire pulled tight when we grabbed the pole it yanked the super drogue away from us, confirming that the chute was still on.)

Windage and water drag corrections have been applied to the standard drogues but the 600-meter anchor drogue requires special comment.

The dotted line connects the actual plotted track of the anchor drogue but the dotted circle around the anchor drogue shows where windage and water drag corrections would have put it. The forces of wind, sea and current acting on the 30-foot anchor drogue were so great as to render the 600-meter drogue measurements meaningless. Still the fact that in spite of all this the drogue not only went up wind and into a nasty sea, and after the change in the tide, ended up not very far from where it started, certainly would at least indicate a net current drift to the NW with a value at least that indicated by the corrected position of the anchor drogue.

After the anchor drogue was retrieved we abandoned the station in the face of continued 25 to 30-knot NW winds and nasty chop, and left the standard drogues to drift in hopes of seeing some of them again when we would return to reoccupy the station.





STATION V

EL GOLFO

November 26 - 27, 1963

We reoccupied Station V for the second time on the afternoon of the 26th, four days after leaving the station. During that time fresh to strong NW winds had prevailed on all but one day. I mention this because during the course of tracking the drogues, we ran across #13 the 100-meter drogue launched in the first set of drogues on the 22nd. Since it had drifted well to the NW in spite of wind and sea, and tidal cycles, it was the most valuable find of all on this station, and confirmed a flow of subsurface water up the Gulf to the NW.

The same old anchor drogue was put out to a depth of 600 meters, then standard drogues at 200, 100, 50 and 10 meters were launched and the initial positions fixed at 1730 on November 26th. The wind piped up to 25 knots out of the NW, and two of the drogues were lost in the sea return on the radar screen as the chop built up, and were never seen again. The wind began to weaken however around midnight, and the sea went down too. We followed the 200 and 10-meter drogues on the radar all night and a third target showed up about 0600 in the morning which turned out to be #13 from the original drogue set.

On the map the tracks of the 200 and 10-meter drogues are shown by a solid connecting line, and the 600-meter anchor drogue by a dotted line.

These positions have been corrected for both windage and water drag. Geographical fixes were made from Isla San Martir 22 miles away using the same bright radar target on that island we had previously used. 4

The results obtained from both drogue sets on Station V indicate a net transport of water below the mixed layer to the NW or up the Gulf in the face of persistent NW winds. The movement of the mixed layer is less clear, but it evidently responds directly to the wind direction, over and above the tidal oscillations that affect all the drogues. The shear zone as determined from the electric BT trace and past experience probably was between the levels of 28 to 40 meters.

The drift values for the 600-meter level can not be accurate due to the intensity of the forces acting on its surface float, a 30-foot bamboo pole and a 2-foot cube of foam for floatation. However, windage and water drag corrections have been obtained for the surface unit and these values applied, but since the corrections sometimes exceeded the values of the observations, no weight should be given to the actual indicated values, but rather to what it did or did not do. In this case it did go NW indicating a persistent current of strength in that direction at 600 meters. It did travel around a bit with the tidal changes, and the changes that affected it did not affect the waters farther up.

Tidal data corrected to PST for November 22:

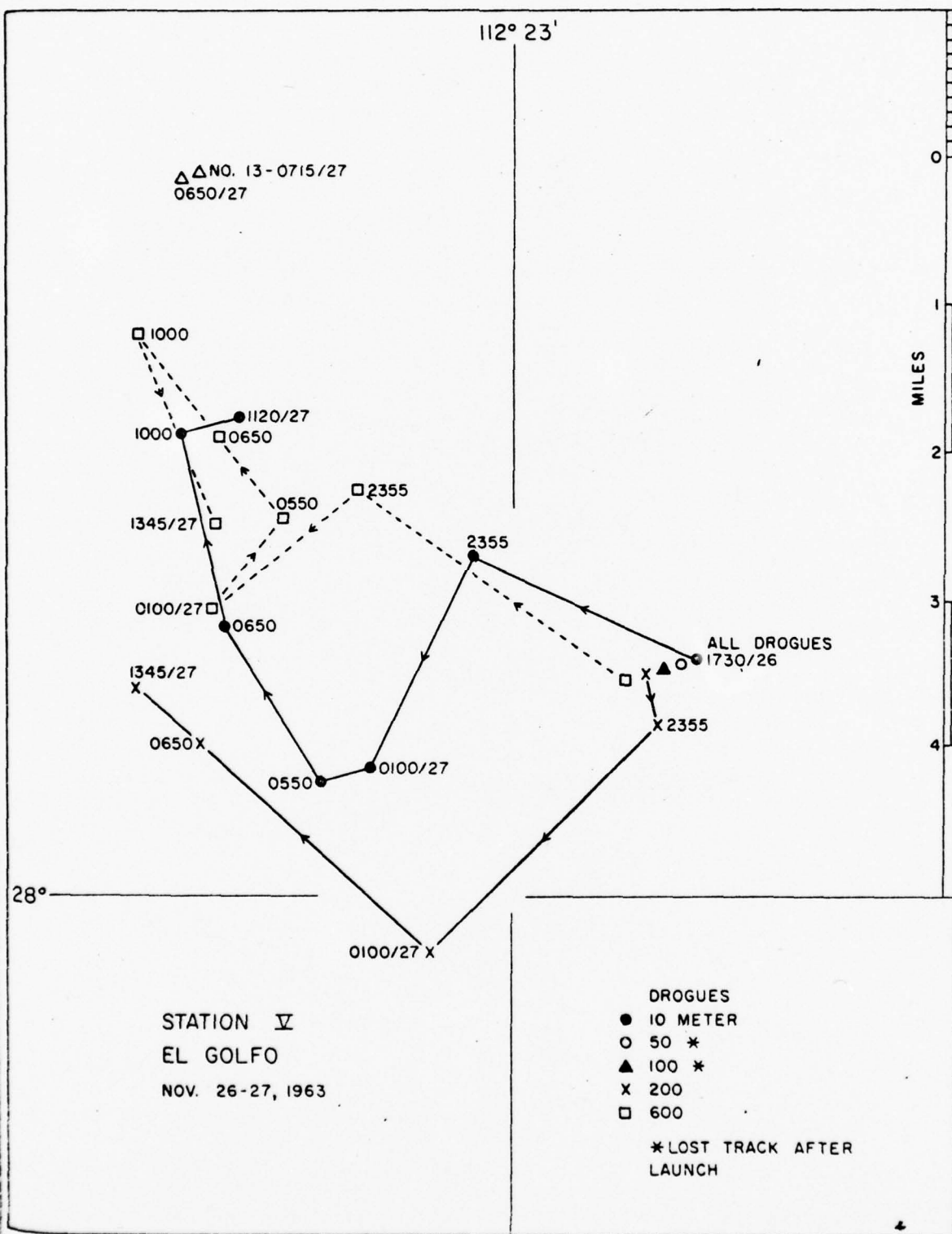
0712      2.4 ft

1915      - .2 ft

---

0641      2.3 ft

1935      - .2 ft



STATION VI

EL GOLFO

Station VI was occupied at a point 4-1/2 miles SW of a prominent point on San Lorenzo Island, in the Salsipuedes Channel at depths of around 800 fathoms.

The reference drogue was launched at 2200 November 23 and allowed to settle down to depth while we did other work around it. The reference drogue was the same large super drogue used on all the previous stations and had out 600 meters of wire. At 0600 the shallower standard drogues were launched, and initially were positioned at 0700 November 24. Drogues with 300, 200, 100, 50 and 10-meter wire lengths launched on this station.

Weather was nearly dead calm throughout most of the survey on this station. The winds were NW when we arrived on station and blew hard all night but began dying by the time we launched the shallow drogues and became calm by about 1000. Wind turned into the south in the late afternoon but never more than 8 knots. Sea state was calm and even glassy in the channel during most of the survey.

Fixes were very good due to the close proximity of the land and the calm sea state, so that even the results of the 600-meter drogue were quite usefull for this station.

It should be noted that the Salsipuedes Channel is actually a long deep basin extending from near the southern end of San Lorenzo Island clear up to the northern end of Guardian Angel Island. The sill depths at both ends and between the island effectively create a large independent basin cut off from deep waters to the south. The sill depth is roughly 400 meters at its deepest points.

From the drogue observations it would appear that the deep water

merely sloshes back and forth in response to the tides, on a course roughly parallel to the axis of the basin which runs NW/SE. The drogues above the sill depth show signs of being dispersed by who knows what forces. The 100, 200 and 300-meter drogues showed a net transport to the WNW while the net transport of the 10 and 50-meter drogues showed a drift to the SE.

The two main forces at work in this basin were the wind and tides.

Tidal data showed the following:

Nov. 23	0547 PST	2.4 ft	Nov. 24	0548 PST	2.4 ft
	2037 PST	- .1 ft		2152 PST	- .1 ft

Like all tidal data for the Gulf the reference station is Guyamas and the times have been corrected to Pacific Standard Time for our locality. Presumably this was the neap tide period with only 2 tides each day so the tidal currents were at a minimum.

The other force, the wind, had been blowing very strongly out of the NW in response to a high pressure cell over the SW United States. Only during our stay on station did it stop blowing, in response to a passing weather front. On the 24th the wind returned in force from the NW complete with a water spout and cold dry air.

The behavior of the drogues would suggest that the following situation was in effect during our stay on station.

- (1) The deep basin water was sloshing in response to the tides.
- (2) The surface waters to a depth of 60 meters (depth of mixed layer shown by electric BT) was drifting SE ward. Probably under the influence of wind stress, with its force opposed or reenforced by the tide.
- (3) The water between 90 and 110 meters was moving NW ward as an undercurrent with the waters at the 200 and 300-meter levels moving NW too but at increasingly sluggish rates, and all of course effected by tidal influence.



A peculiar portion of the electric BT trace in the area between 90 and 110 meters (at high tide) and a similar wobble in the trace in the 130 to 150-meter level (at low tide) would tend to bear out the actions of the 100 and 200-meter drogues, which traveled together, that the swiftest part of the water flowing NW was between the levels of 100 to 200 meters.

TIMES OF OBSERVATIONS

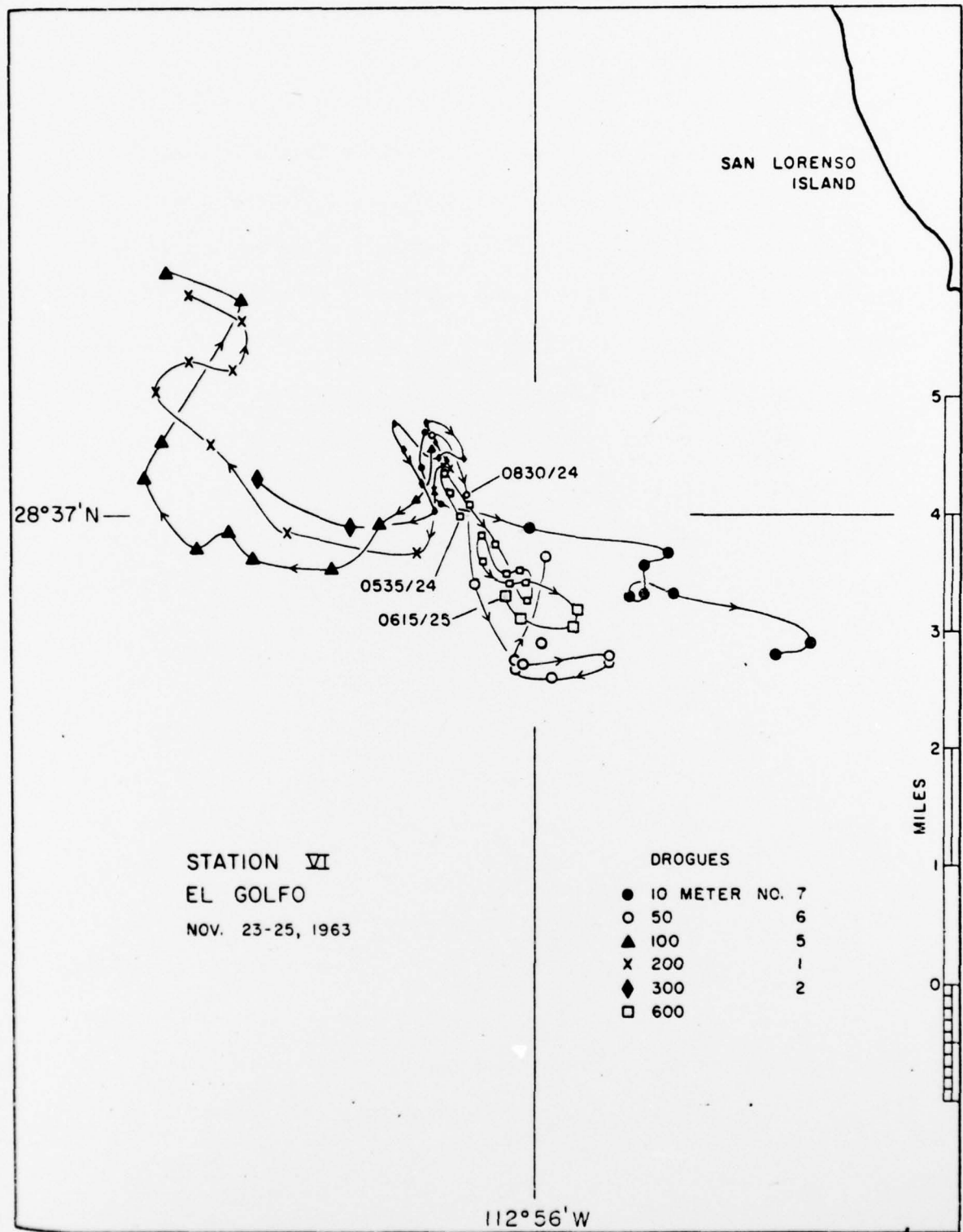
STATION VI - EL GOLFO

Starting positions of 600 meter drogue is indicated by an "X" within a square, and the time 0535 PST on the 24th of November is indicated on the map. Time and date of terminal position is similarly indicated. Track of 600-meter drogue is correctly shown from all fixes, but only those successive positions in the table below are shown.

The shallow drogues were initially all positioned at 0700 PST November 24, 1963 and the times of observation of each successive plot is listed below:

Initial fix	0700/24th	0001/25th
	0830	0150
	1030	0345
	1400	0530 Terminal fix
	1800	
	2000	
	2200	

Due to confusion on the tracks the 2nd or 0830 fix of drogue #6 is not connected to the launching fix.



URSA MAJOR

ANCHOR-DROGUE STATION

August 31 - September 2, 1964

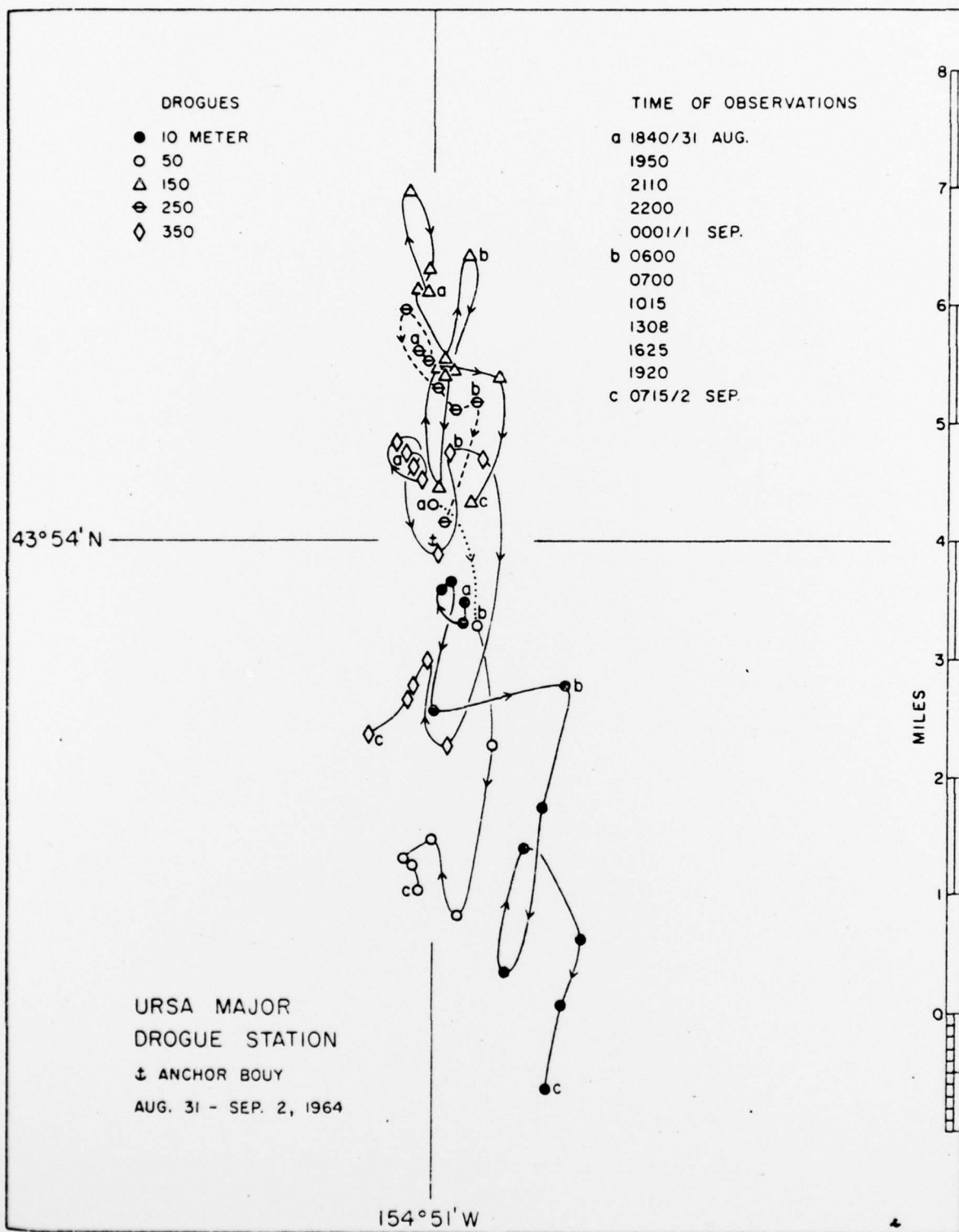
As part of a detailed biological cross section of the North Pacific during the URSA MAJOR Expedition, a drogue station was run to get direct current measurements in the area of the faunal transition zone. This biological boundary or transition zone was under special study during this expedition to determine its nature and the distribution of plankton in it. To measure the potential effects of currents on this distribution, a parachute drogue station was occupied for several days.

An anchor-reference buoy was first put down, anchored in 3000 fathoms of water over a smooth bottom. This anchored reference point was essential for current measurement, since there was little sun, and no effective Loran so far out in the Pacific, for precision navigation. All drogue movements were measured by radar ranges and bearings relative to this anchored station. The anchor station was very stable in its location since it could be checked for movement by its relation to a prominent feature on the ocean floor. It had no detectable movement during the entire time on station.

Five drogues were launched in a line N/S of the anchor buoy. Parachutes were sent to 5 depths; 10, 50, 150, 250, and 350 meters to measure the subsurface as well as the surface currents. Five hydrographic stations were also run in a dice pattern around this station to give additional information on the local currents. The anchor station was designated as STA. 26.2 located at 43° 54' N, 154° 51' W.

Drogues were launched on the afternoon of August 31, 1964 on a N/S line, but the first fix or position shown on the chart was not made until all the drogues had had time to settle to their operating depths. This first fix is circled on the chart, at 1840/31. The tracks of the drogues, are shown by their successive positions. Times of these positions are indicated in the list on the chart. Drogue positions were all recorded at one time relative to the anchor buoy during each fix. All positions have been corrected for windage and current drag on the drogue poles. Wind was from the south 8 to 10 knots during most of the survey but the seas were slight except on the first night. The 50-meter drogue could not be seen on radar at close range due to a faulty reflector so there is a gap in its position between its first fix and its dawn fix at 0600 on the 1st of September. Terminal positions at 0715/2 are also circled. The 250-meter drogue tangled with the anchor buoy and sank at 0725 on the 1st of September.

For the most part the drogues all moved southward at a very sluggish overall pace. Most of the movement was in north and south oscillations. At first we thought the anchor buoy was responsible for this, but it did not move at all when referenced to a nearby feature on the ocean bottom, so the movement was due to the water. The sluggish pace and southerly direction was something of a surprise to us since the station was in the heart of the westerly wind drift, indicated on most pilot charts.





BANCO SAN ISIDRO

DROGUE SURVEY

November 20 - 24, 1964

A number of drogues were laid out on both sides of an offshore bank. These were used to determine the water flow in the area around the bank in conjunction with a biological study of the fauna on and around the bank.

The bank was in the form of an offshore ridge about 6 miles long lying parallel to the coast. Least depths over the bank were 52 fathoms (94 meters). Between the ridge and the coast lay a valley open at both ends going down to a depth of 120 fathoms. Offshore of the ridge was a steep drop to 400 fathoms and more.

Figure I shows the general area of the bank and the direction of travel of all the drogues. It will be noticed that the 100 and 200-meter drogues offshore from the ridge went out to sea while the surface water on the first day was pushing onshore and right over the ridge. In the valley, the 200-meter drogue was actually a 175-meter drogue due to depth limitations. This drogue went NW paralleling the valley. The 100-meter drogue did the same until it ran aground. A strong current was setting NW up the coast inshore of the 100-fathom line. These drogues all disappeared out of range within a day.

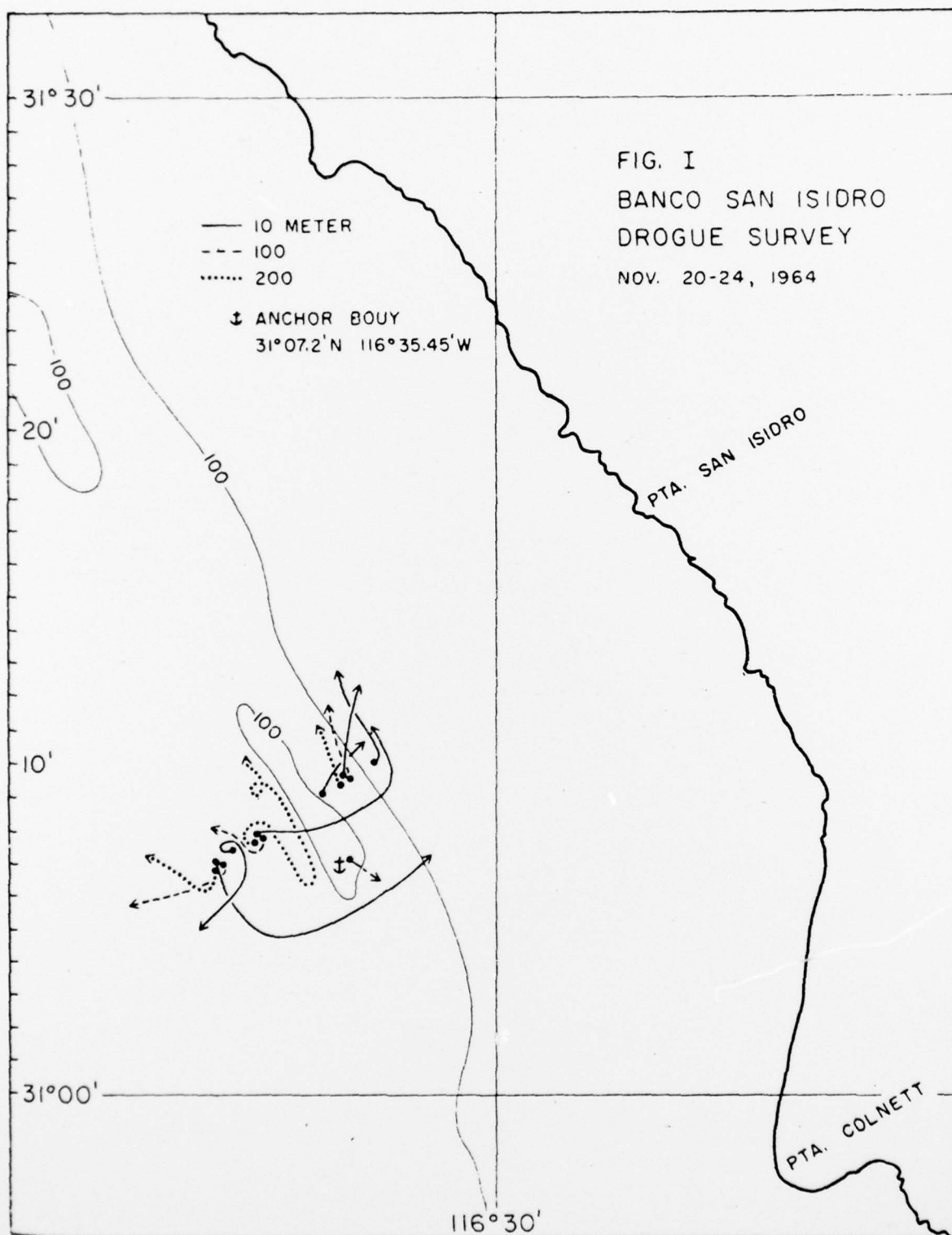
A study of Figure II which shows the paths of the 10-meter drogues will reveal that on the 20th the surface water was all moving onshore. When swept inside the 100-fathom line they were turned NW in a strong inshore countercurrent. In order to determine the persistence of the onshore push of the current, another 10-meter drogue was launched into

the offshore water. This drogue (#12) moved very little at first, then started SW away from the coast. A drogue (#14) was launched on the 23rd over the top of the bank, and it went SE, all of which showed that the water around the bank ebbed and flowed over it in long surges and at times with considerable strength.

Figure III shows the paths of the 100 and 200-meter drogues. The deeper water here on both sides of the ridge seems to be heading NW as an undercurrent running opposite to the surface current. The 200-meter drogue (#8) however, appeared to be trapped by an eddy in the lee of the ridge. This same deep water push to the NW showed up in the valley with some tendency for the water to sweep inshore and up slope, judging by the behavior of #3, a 100-meter drogue which ran aground.

On the drogue charts, the first and last fixes are shown with their times and dates. Each successive position is shown and the times for these observations are listed in order on a separate list so that the reader may extract whatever degree of information he wishes from this information.

All fixes were by radar ranges and bearings from an anchored radar tower, moored on top of the ridge near its south end. Wind and seas were calm during the time of survey, so that no windage corrections have had to be used.



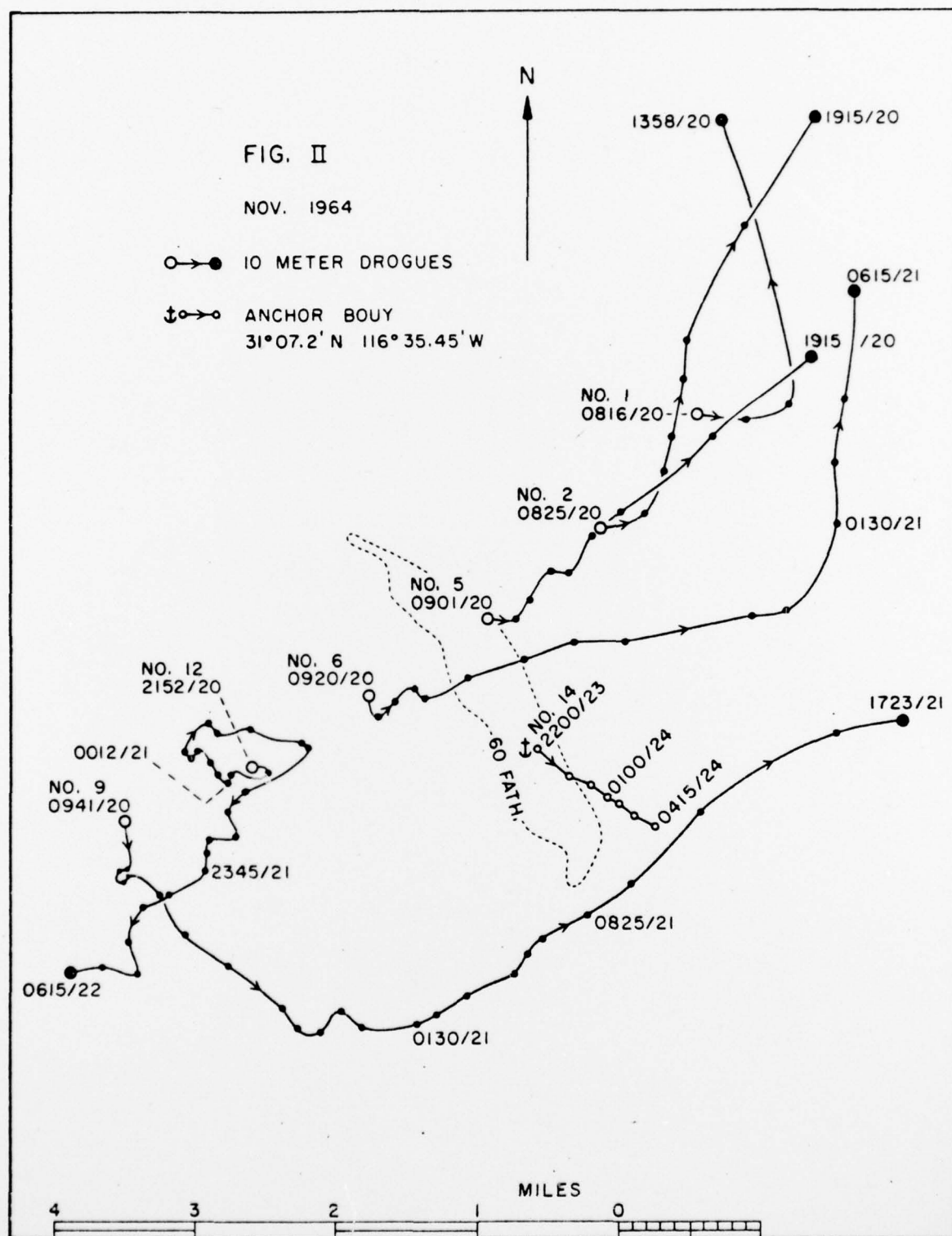
TIMES OF OBSERVATIONS

The path of each drogue is shown by position marks along its track.  
The times of these fixes is listed below in the order shown on the charts.

Figure II

10-Meter Drogues

<u>#1</u>	<u>#9</u>	<u>#6</u>	<u>#12</u>
Time/Date	Time/Date	Time/Date	Time/Date
0816/20	0941/20	0920/20	2152/20
0850/20	1055/20	1100/20	2222/20
1055/20	1200/20	1200/20	2332/20
1358/20	1230/20	1230/20	0012/21
	1330/20	1330/20	0100/21
<u>#2</u>	1430/20	1430/20	0155/21
0825/20	1535/20	1535/20	0243/21
1055/20	1715/20	1600/20	0300/21
1230/20	1915/20	1715/20	0330/21
1330/20	2045/20	1915/20	0530/21
1430/20	2150/20	2045/20	0645/21
1535/20	2255/20	0130/21	0940/21
1715/20	2345/20	0255/21	1210/21
1915/20	0130/21	0420/21	1423/21
<u>#5</u>	0255/21	0615/21	2010/21
0901/20	0420/21		2056/21
1055/20	0525/21	<u>#14</u>	2150/21
1200/20	0615/21	2200/23	2255/21
1230/20	0715/21	2300/23	2315/21
1330/20	0825/21	2400/23	2345/21
1430/20	0957/21	0100/24	0130/22
1535/20	1223/21	0200/24	0255/22
1715/20	1556/21	0300/24	0420/22
1915/20	1723/21	0415/24	0525/22
			0540/22
			0615/22



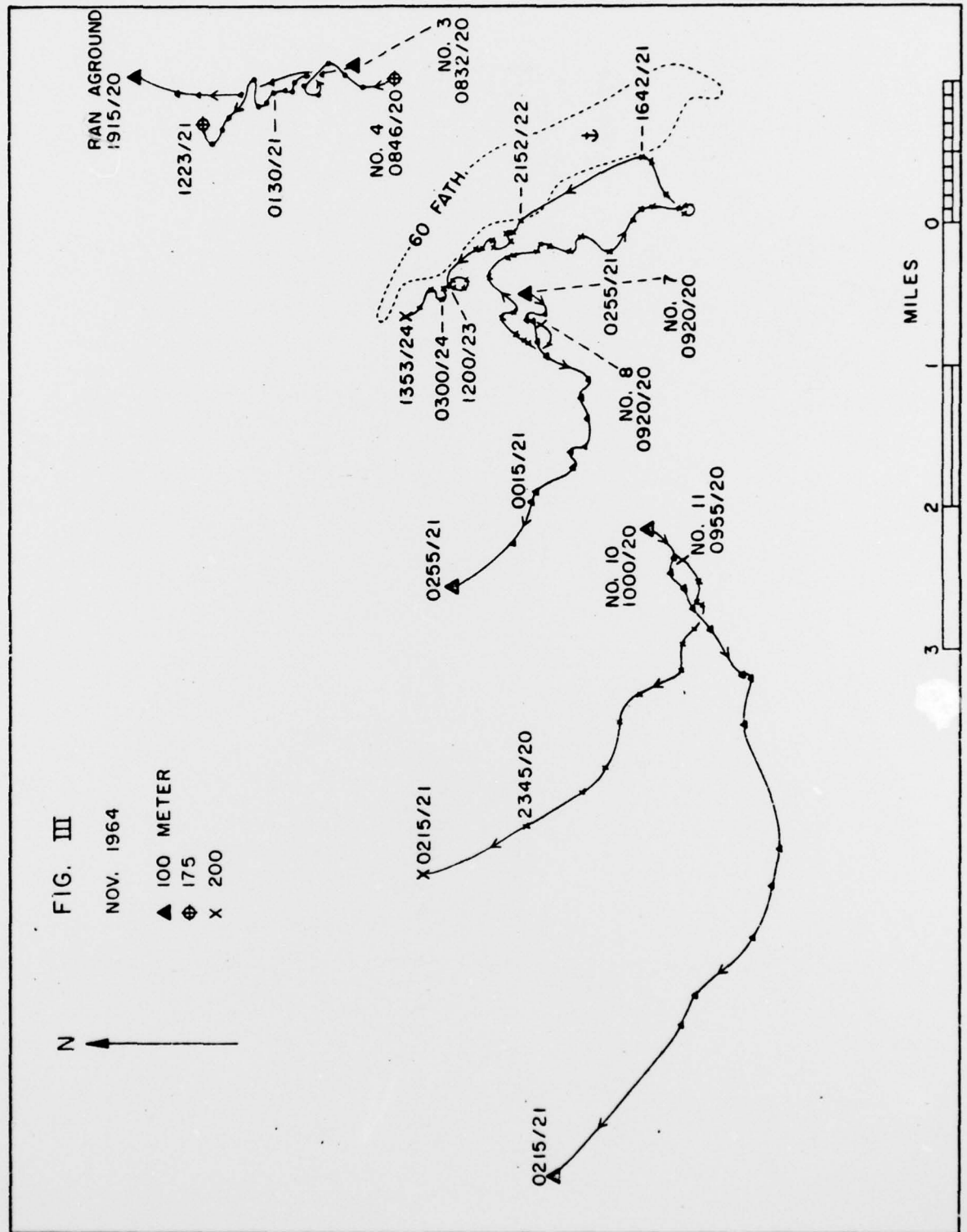


TIMES OF OBSERVATIONS

Figure 111

<u>#3-100 Meter</u>	<u>#8-200 Meter</u>	<u>#8-Cont.</u>	<u>#10-100 Meter</u>
Time/Date	Time/Date	Time/Date	Time/Date
0832/20	0920/20	0645/23	1000/20
1055/20	1055/20	0700/23	1055/20
1230/20	1200/20	1200/23	1200/20
1330/20	1230/20	1300/23	1230/20
1430/20	1330/20	1423/23	1330/20
1535/20	1430/20	1745/23	1430/20
1915/20	1535/20	2300/23	1535/20
Aground	1715/20	2400/23	1600/20
	1915/20	0200/24	1715/20
<u>#4-175 Meter</u>	2045/20	0300/24	2005/20
0846/20	2150/20	0415/24	2045/20
1055/20	2235/20	0840/24	2150/20
1230/20	2345/20	1232/24	2255/20
1330/20	0015/21	1353/24	2345/20
1430/20	0130/21		0215/21
1535/20	0255/21	<u>#7-100 Meter</u>	
1715/20	0420/21	0920/20	<u>#11-200 Meter</u>
1915/20	0525/21	1000/20	0955/20
2045/20	0615/21	1200/20	1055/20
2345/20	0715/21	1230/20	1200/20
0130/21	0825/21	1330/20	1230/20
1255/21	0957/21	1430/20	1330/20
1420/21	1223/21	1535/20	1430/20
1525/21	1556/21	1715/20	1600/20
0615/21	1642/21	1915/20	1715/20
0715/21	2152/22	2005/20	1915/20
1029/21	2322/22	2056/20	2045/20
1223/21	0012/23	2150/20	2150/20
	0100/23	2255/20	2345/20
	0330/23	0015/21	0215/21
	0600/23	0130/21	
		0255/21	





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